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(54) Tube heat exchanger

(57) The present invention concerns a tube heat exchanger comprising heat surface tubes (6) surrounded by a shell (1), said tubes communicating with an inlet end chamber (11) through a tube platet (5) at one end and with an outlet end chamber (12) through a tube plate (4) at the other end, and in the shell side of the tube heat exchanger there it at least one baffle plate (7) made of thin sheet strips (21) for supporting the heat surface tubes (6) and guiding the shell-side flow. The invention is characterized in that the sheet strips (21) forming the baffle plate (7) are thinner than the distance between the tubes (6) to be supported, and that the required support is achieved by placing each sheet strip (21) of the baffle plate (7) in an inclined position with respect to the heat surface tubes (6) so that one of the crosswise edges of the sheet strip (21) is supporting one and the other is supporting the other of adjacent tubes (6). (Fig. 1)

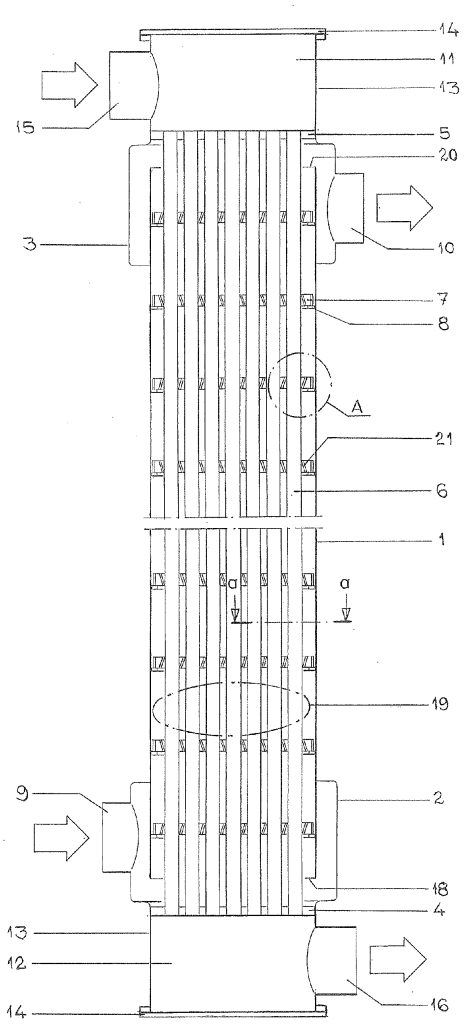

Fig. 1

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Description

[0001] The present invention concerns a tube heat exchanger comprising heat surface tubes surrounded by a shell, said tubes communicating at one end with an inlet end chamber via a tube plate and at the other end with an outlet end chamber via a tube plate, and in the shell side of the tube heat exchanger there is at least one baffle plate made of thin sheet strips for supporting the heat surface tubes and for guiding the shell-side flow.

[0002] The most general solution used for guiding the shell-side flow and for supporting the heat surface tubes is to use segmental guiding/supporting baffles made of a plate. The construction and dimensioning of this kind of baffles has been well discussed e.g. in the TEMA standard (Standard of the Tubular Exchanger Manufacturers' Association). A weakness of these baffles is that in the corners formed by the heat exchanger shell and the baffle plates there are "blind areas", where the flow speed is low and the heat transfer weak, and these areas also easily get contaminated, and the support provided by them for the heat surface tubes against vibration and buckling is insufficient, especially, when tubes with a small diameter and thin walls are to be used in heat exchangers with a large diameter.

[0003] U.S. Patent Publication No. 5,642,778 discloses another solution for supporting heat surface tubes. There, the heat surface tubes are supported by means of an outer ring and round baffle rods attached thereto in parallel. The desired pitch and supporting of the tubes is provided by changing the thickness and number of the rods of the baffle. When the baffles are positioned crosswise, a four-point support is provided for each heat surface tube. One four-point support requires two or four sequential crosswise arrangements of rod baffles. Weaknesses of this kind of supporting are that a big amount of rod baffles is required for providing a sufficient support, the long rods of the baffles easily start vibrating, which can lead to their breaking, and that pressure loss in the shell-side is relatively high.

[0004] The object of the present invention is to develop a tube heat exchanger, wherein the shell-side flow is guided so as to achieve a heat transfer as efficient as possible with a predetermined pressure loss, and at the same time a sufficient support of the heat surface tubes is provided, to prevent damaging of the tubes by vibration and/or buckling of the tubes, and to overcome the aforementioned drawbacks. This object is achieved by means of a tube heat exchanger that is characterized in that the thickness of sheet strips forming a baffle plate is smaller than the distance between the tubes to be supported, and that the required support is provided by placing each sheet strip of the baffle plate in an oblique position with respect to the heat surface tubes so that one of the crosswise edges of the sheet strip supports one of two adjacent tubes and the other supports the other. The tube heat exchanger can be installed either in a vertical position or a horizontal position. Due to the baffle plate in accordance with the invention, each heat surface tube is supported at four points, and at the same time, there are no blind areas left in the construction that would be subjected to contamination and would weaken the heat transfer. Due to this kind of baffle plates, an even shell-side flow and a good heat transfer along the total length of the heat surface tubes can be achieved. The pressure loss is low, because only 10 to 20 % of the cross-sectional flow area at the shell side is covered by baffle plates.

[0005] A groove parallel with the heat exchange tube can be advantageously formed or machined in the points of the sheet strip edges of the baffle plates that support the heat surface tubes, in order to make the contact surface between the tube and the sheet strip larger.

[0006] The heat surface tubes can either be straight, whereby the inlet end chamber is located in one end of the tube heat exchanger and the outlet end chamber is located in the other end of the tube heat exchanger, or they can be formed as a U, whereby the inlet end chamber and the outlet end chamber are located in the same end covered by a common shell so that said chambers are separated from each other by a partition wall.

[0007] Good heat transfer and low contamination combined with a small pressure loss lead to a tube heat exchanger having both a smaller heat surface and a smaller size.

[0008] The baffle plate in accordance with the invention is, in addition to one-phase flow, also applicable to use in vaporizers and condensers.

[0009] The baffle plate in accordance with the invention is also applicable for heat surface tubes with different profiles and/or fins.

[0010] The invention will be described in more detail in the following, with reference to a drawing, wherein

Figure 1 shows a cross-sectional view of a single tubepass tube heat exchanger with straight tubes and fixed tube plates;

Figure 2 shows an enlarged detail A of Figure 1;

Figure 3 shows an enlarged section a-a of Figure 1;

Figure 4 shows a corresponding section as in Fig. 1, where the heat surface tubes are arranged in the form of an equilateral triangle;

Figure 5 shows an example, how the edges of the sheet strip of the baffle plate can be formed at the contact point with the heat surface tubes; and

Figure 6 shows an example, how the edges of the sheet strip of the baffle plate can be machined at the contact point with the heat surface tubes.

[0011] The shell side of the heat exchanger is formed of a cylindrical shell 1 being connected to tube plates 4 and 5 via expanded shell and bellow parts 2 and 3. The

heat surface tubes 6 are fixed at their ends to said tube plates 4 and 5. Baffle plates 7 arranged at predetermined distances for supporting the tubes and for guiding the flow are fixed to the shell 1 by means of rings 8. Shell-side pipe connections 9 and 10 are fixed to the expanded shell parts 2 and 3.

[0012] The tube side end chambers 11 and 12 are formed of a cylinder shell 13 and an openable end plate 14. Tube side pipe connections 15 and 16 are fixed to the shell part 13 of the chambers.

[0013] A heat exchanger according to Figure 1 is suitable for heat transfer both for liquid and steam/gas flows.

[0014] The heat emitting medium flows to the tube side inlet end chamber 11 of the heat exchanger through the pipe connection 15 and further to the heat surface tubes 6. Medium flowing downwards in the heat surface tubes 6 cools down and is passed out from the heat exchanger through the outlet end chamber 12 and the pipe connection 16.

[0015] The heat receiving medium is led through the pipe connection 9 to the expanded lower part 2 of the shell side, where the flowing medium is distributed so as to flow under a plate edge 18 evenly over the total peripheral length around the tube bundle 19. The flowing medium fills the shell volume between the tubes and flows in this space parallel with the tubes from down upwards.

[0016] The heat surface tubes 6 pass through the baffle plates 7 according to the invention located in the shell side at predetermined distances. The baffle plates 7 support the heat surface tubes 6 and increase the turbulence of the medium flowing axially between the tubes, thus intensifying the heat transfer.

[0017] The medium flowed from down upwards through the shell part flows over a plate edge 20 to the expanded upper part 3 of the shell side, from where it is passed out from the heat exchanger through the pipe connection 10.

[0018] The baffle plates 7 according to the invention are formed of thin slotted and inclined sheet strips 21 placed crosswise. Figure 2 shows how the sheet strip 21 of the baffle plate 7 is inclined for an angle α, whereby the left lower edge of the strip 21 supports one and the right upper edge another heat surface tube 6. Each of the thickness s, width 1 and angle α of the sheet strip 21, can be changed in order to provide a desired guiding and supporting baffle.

[0019] Figure 3 shows the construction of a baffle plate 7 providing four point support, when the heat surface tubes 6 are arranged in a square form, and Figure 4 shows the construction of a baffle plate 7, when the arrangement of the heat surface tubes 6 has the form of an equilateral triangle.

[0020] In Figure 1, the baffle plate 7 is supported onto a ring 8 fixed to the shell 1. The ring acts at the same time as a sealing fin preventing the flow from passing by the tube bundle 19. The baffle plates 7 can also be supported by means of tie rods, like the plate shaped guiding/support baffles in conventional tube heat exchangers.

[0021] Points of the baffle plates 7 left without tubes can either be made of a plate or be covered by a (thin) sheet for preventing detrimental bypass and leakage flows. For decreasing the pressure loss caused by the baffle plate 7, it is advantageous to chamfer the edges of the sheet strips forming the baffle plate 7, as shown in Figure 2.

[0022] The support surface at the contact point between the sheet strip 21 of the baffle plate 7 and the heat surface tube 6 can be increased e.g. as shown in Figure 5. It shows a groove pressed to the edge of the strip 21 at the contact point with the tube 6 to be supported, corresponding to the curvature of the tube, whereby the contact surface of the sheet strip 21 with the tube is increased both in the lateral and in the vertical direction.

[0023] In Figure 6, the corresponding groove in the edge of the sheet strip 21 has been made e.g. by grinding. A larger support surface supports the tube 6 better and enables the use of tubes being corrugated, profiled or finned in various ways in the heat exchangers according to the invention.

Claims

1. A tube heat exchanger comprising heat surface tubes (6) surrounded by a shell (1), said heat surface tubes (6) communicating with an inlet end chamber (11) through a tube plate (5) at one end and with an outlet end chamber (12) through a tube plate (4) at the other end, and in the shell side of the tube heat exchanger there is at least one baffle plate (7) made of thin sheet strips (21) supporting the heat surface tubes (6) and guiding the shell-side flow, **characterized in that** the sheet strips (21) forming the baffle plate (7) are thinner than the distance between the tubes (6) to be supported, and the required support is provided by placing each sheet strip (21) of the baffle plate (7) in an inclined position with respect to the heat surface tubes (6) so that one of the crosswise edges of the sheet strip (21) is supporting one and the other is supporting the other of adjacent tubes (6).

2. A tube heat exchanger according to Claim 1, **characterized in that** each heat surface tube (6) passing through the baffle plate (7) is supported by the sheet strips (21) of the baffle plate (7) at four points.

3. A tube heat exchanger according to Claim 1, **characterized in that** at the edges of the sheet strips (21) of the baffle plate (7) there is formed or machined a groove parallel with the tube (6) at the points supporting the heat surface tubes (6), said groove enlarging the contact surface between the tube (6) and the sheet strip (21).

4. A tube heat exchanger according to any of the preceding claims, **characterized in that** the heat surface tubes (6) are straight, whereby the inlet end chamber (11) is located in one end of the tube heat exchanger and the outlet end chamber (12) in the opposite end of the tube heat exchanger.

5. A tube heat exchanger according to any of the Claims from 1 to 3, **characterized in that** the heat surface tubes (6) are U-formed, whereby the inlet end chamber and the outlet end chamber are located in the same end of the tube heat exchanger surrounded by a common shell (13), said chambers being separated from each other by means of a partition wall.

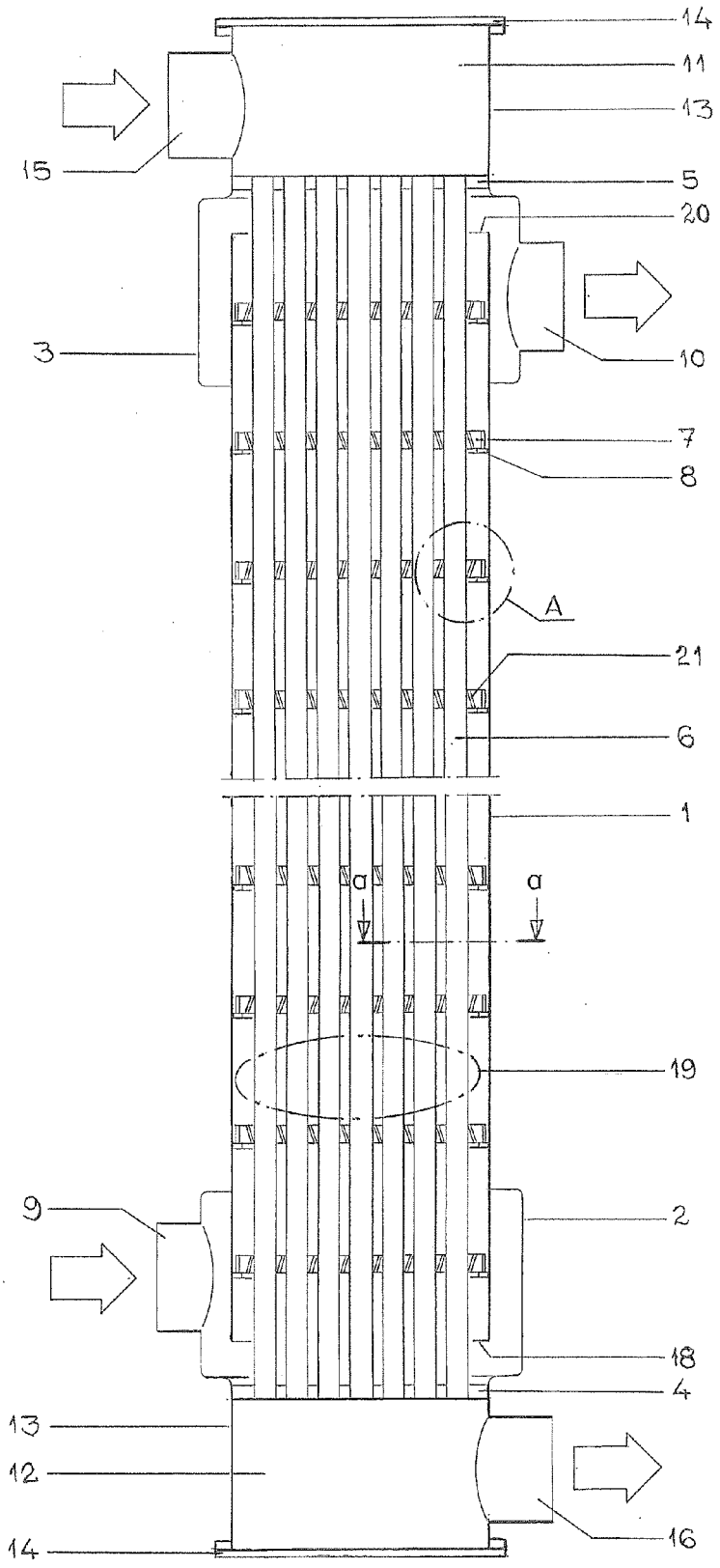

Fig. 1

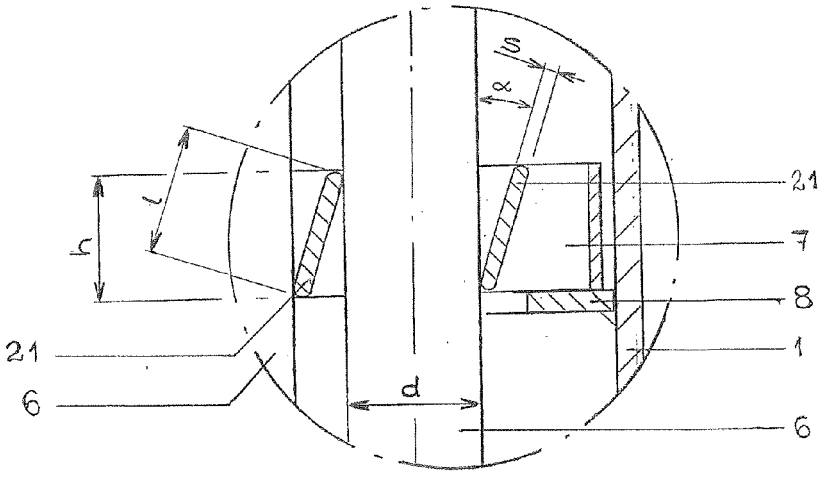

Fig. 2

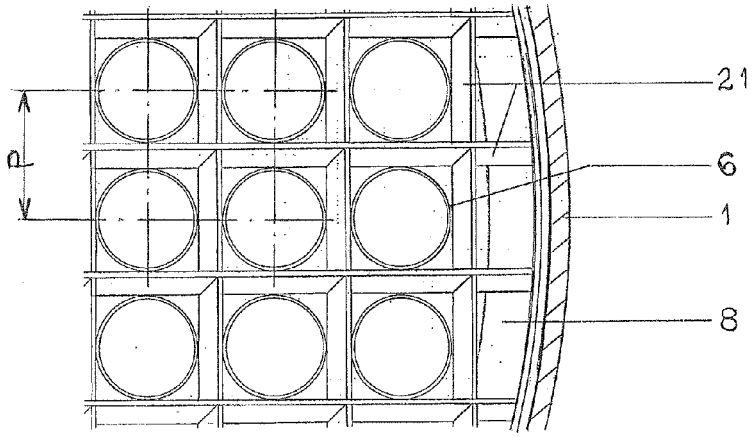

Fig. 3

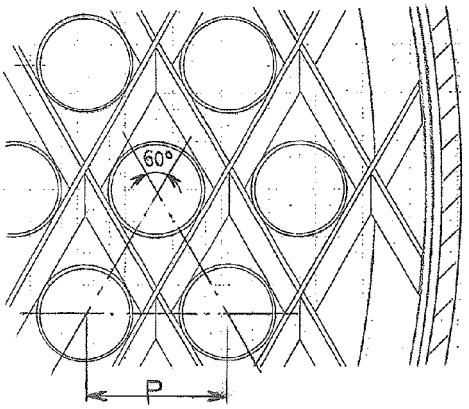

Fig. 4

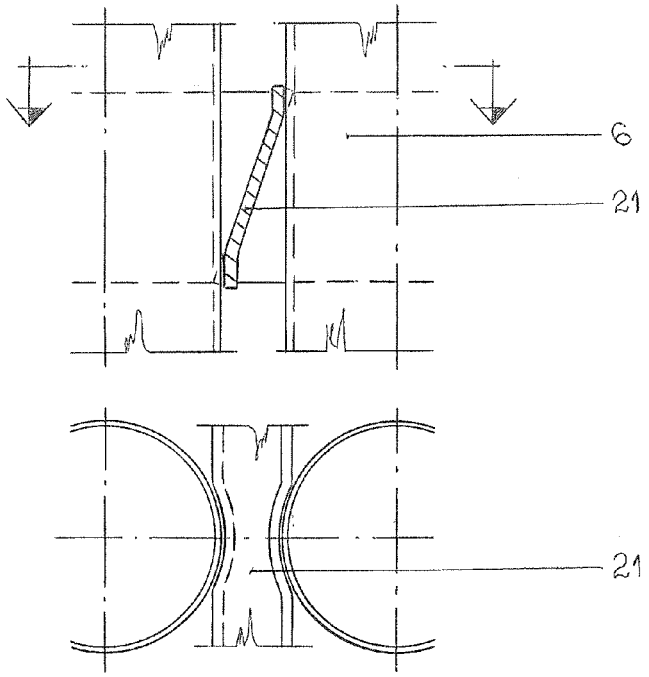

Fig. 5

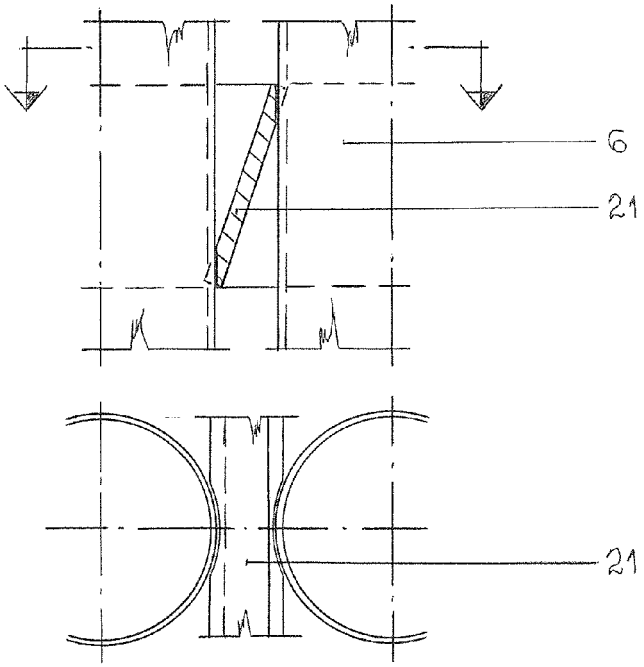

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 10 39 7525

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 764 866 A (WELLINGTON TUBE WORKS LTD) 2 January 1957 (1957-01-02) * page 1, line 32 - line 47; figures 1,2 *	1,2,4 3,5	INV. F28F9/013 F28D7/16
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A	US 4 919 199 A (HAHN ROBERT B [US]) 24 April 1990 (1990-04-24) * column 5 - line 54; figures 1-4 *	1-5	
A	DE 930 146 C (ATLAS WERKE AG) 11 July 1955 (1955-07-11) * figures 1-3 *	1-5	
A	US 4 204 570 A (EISINGER FRANTISEK L [US]) 27 May 1980 (1980-05-27) * figure 8 *	1-5	TECHNICAL FIELDS SEARCHED (IPC) F28F F28D F16L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 May 2011	Mootz, Frank

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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